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Report of the PSARC Habitat Subcommittee Meeting, June 26-27, 2001

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PACIFIC SCIENTIFIC ADVICE REVIEW COMMITTEE

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HABITAT

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SUMMARY

The Pacific Scientific Advice Review Committee (PSARC) Habitat Subcommittee met June 26-27, 2001 at the Institute of Ocean Sciences (IOS) in Sidney, B.C. The Subcommittee formally reviewed five Working Papers. Working paper titles, authors and reviewers are included as Appendix 1.

INTRODUCTION

The Acting Subcommittee Chair, Dr. John Pringle, welcomed Subcommittee members, introduced observers and external participants, and explained rules for their participation. The Subcommittee accepted the meeting agenda (Appendix 2).

During the introductory remarks the objectives of the meeting were reviewed, as was the process to be followed. Participants (Appendix 3) were reminded the meeting deliberations are confidential until publication of the meeting's Advisory Document.

WORKING PAPER SUMMARIES, REVIEWS AND DISCUSSION

H2001-01: Factors limiting sockeye production on selected B.C. nursery lakes

K.S. Shortreed, K.F. Morton, K. Malange, and J.M.B. Hume **Accepted subject to revisions**

Summary

This report presents summaries of current knowledge of those freshwater factors limiting sockeye production in 60 B.C. lakes; about two-thirds of B.C.'s sockeye nursery lakes. Total surface area of lakes studied was 3,586 km²; ~90% of the total area of B.C. nursery lakes. Data presented here were collected between 1977 and 2000. The lakes are located in five of the six DFO Pacific Region's management Areas: none are in the Yukon-Transboundary; four are in the Lower Fraser; six are in the South Coast; eight are in the Central Coast; 17 are in the B.C Interior, and 25 are in the North Coast. Quality and quantity of data available varied among lakes, ranging from intensive multi-year ecosystem studies to one-time limnological surveys. Freshwater factors limiting sockeye production in these lakes varied, but in the majority of lakes, and for most years, fry abundance is insufficient to fully utilize productive capacity. Most lakes are oligotrophic, thus juvenile sockeye growth and/or survival could be improved where nutrients are limiting. The authors identify opportunities for enhancement and/or restoration of each lake's sockeye population, which in addition to lake fertilization, includes

enhanced escapements, fry outplants, spawning channels, improvements to spawning grounds, and control of competitors and/or predators.

Reviewers' Comments

Reviewer 1

This reviewer felt the working paper will serve the Lake Enhancement Program managers well, and that the authors went well beyond the original modest request of "a few paragraphs on each lake" covering "water quality parameters" and "descriptive text". He consequently suggested the title be changed to; "Factors limiting juvenile sockeye production and enhancement potential for selected BC nursery lakes". The information generated in the study is used in decision making around nursery lakes that might benefit from lake fertilisation. The authors have produced a document that clearly identifies the potential of the lakes for sockeye enhancement through nutrient enrichment.

The reviewer provided an extensive review that was turned over to the authors. He urged that the limnetic fish population estimates and zooplankton sections reference the methods and data sources used for coastal lakes. He noted that for some fertilized lakes, modest differences in plankton productivity or biomass parameters are interpreted as a successful response to fertilization (e.g. Kitlope, Adams). With the exception of some heavily loaded coastal lakes, the responses to fertilization can be equivocal. This interpretation problem plagues whole-lake treatment studies where suitable temporal and spatial controls along with the use of replicates are wanting. The authors were urged to both acknowledge this concern in some of the individual lake discussions, and to stress the importance of multi-year pre-treatment, treatment, and post-treatment data (similar to the Chilko Lake study) as one solution, though the most scientifically rigorous approach would be a replicated experimental design.

The reviewer suggested a need for additional studies on the fate and ecological roles of salmon carcasses in sockeye lakes; despite > 20 years of nutrient enrichment, it is not yet clear whether it is equivalent to the effects of natural carcasses. In addition, photosynthetic rate (PR) estimates of optimum escapements and rearing capacity are dependent on data from small Alaskan sockeye lakes and a few large Fraser River lakes. There is need for complimentary studies on small B.C. lakes and coastal rearing habitats. Small coastal lakes may have significant benthic-pelagic interactions that affect their productivity and overall rearing capacity for sockeye.

It was further noted that two controversial assumptions have shaped the lake enrichment program, though they have yet to be validated: first, what is the ecological value of nutrient enrichment at low sockeye densities? And secondly, that at high juvenile sockeye densities, enrichment will not be effective because top-down grazing pressure constrains zooplankton responses. These

assumptions should be discussed in the working paper, because they shape the way candidate lakes are selected. Interestingly, small glacial lakes such as Taseko, Bowser, Owikeno, and Kitlope have productivity constraints yet they support productive sockeye populations. Insufficient information is known about their ecology to know if other enhancement strategies (e.g., littoral enrichment) could be effective.

Reviewer 2

This reviewer congratulated the authors on a fine job of pulling together a wide range of data on a large number of B.C. sockeye nursery lakes, and noted that the working paper should be useful to Area Managers and salmon enhancement staff. In addition, the information on the utility of various enhancement techniques for particular stocks should be of particular use to management. The document forms a solid basis for further study and discussion.

Since the current paper is so extensive in its coverage, the authors are only able to touch, in the briefest way, on factors constraining sockeye production in each lake, thus rather than state that the document is a "discussion", they should use the term "list of information". A number of specific changes were submitted to the authors.

Subcommittee Discussion

The Subcommittee felt the working paper provides an excellent summary of the available information on B.C. sockeye nursery lakes. It was agreed, additional data are required on certain lakes in order to improve the technical analysis for sockeye stock rebuilding options.

The Subcommittee felt it would be useful to revise the methodology section of the working paper to state explicitly what technical criteria were used to arrive at specific conclusions. In particular, there is a need for the authors to separate those recommendations, based on expert opinion, from those based on technical analysis. It was also suggested that the authors add a concluding paragraph on both management and scientific recommendations.

The application of the photosynthetic rate (PR) model to determine optimum adult spawner escapement per lake was thoroughly discussed; it was deemed an appropriate technique and its use was supported by the Subcommittee.

Subcommittee Recommendations

1. The Subcommittee recommended that the working paper be accepted, subject to revisions.

2. That additional data are required for several lakes (e.g., Lower Fraser Lakes)

before management advice is provided on sockeye stock-rebuilding options for these lakes.

3. The application of the photosynthetic rate (PR) model in the paper to arrive at optimum adult spawner escapements is supported by the Subcommittee.

4. If fertilization is to be continued, additional assessment of impacts on lake ecosystems and non-target species needs to be undertaken.

5. Resource managers need to consider consequences of sockeye stock rebuilding management options on small stocks in relation to the draft Wild Salmon Policy.

H2001-02: Community structure in goose barnacle (*Pollicipes polymerus*) and sea mussel (*Mytilus californianus*) beds off the west coast of Vancouver Island, British Columbia

G.S. Jamieson, S. Dixon, and R. Lauzier **Accepted subject to revisions**

Summary

Goose barnacles (*Pollicipes polymerus* Sowerby, 1833) have been harvested off the west coast of Vancouver Island since 1985. Preliminary analysis, however, indicates that harvesting sea mussels (*Mytilus californianus*) might have a significant ecological impact. The fishery was thus closed in May, 1999, and activity was directed to an assessment of the environmental effects of commercial goose barnacle fishing techniques.

M. californianus plays a structural role in certain nearshore habitats, however the overall ecological role is not well understood. Studies were initiated in 2000, with the following objectives: 1) To evaluate the ecological role of goose barnacles in the exposed rocky intertidal zone; 2) To conduct goose barnacle biomass estimates in limited areas; and 3) To make management recommendations, from an ecological perspective, on how a commercial goose barnacle fishery, if reopened, should proceed. Presented here are initial observations on goose barnacle/sea mussel community structure, and the interaction between goose barnacle harvesters and the environment.

Species diversity within the exposed rocky intertidal zone is a function of matrix thickness (the combined layer of living animals, dead shells and associated debris). Following screening with a 1.0 mm sieve, 142 species were identified. Species observed consisted of gastropods (40%), arthropods (20%), annelids (16%), echinoderms (7%), molluscs (5%), cnidarians (3%), unknowns (4%); and insects, chordates, and sipunculas (5%). Sea mussels and goose barnacles predominated at an intertidal elevation of 2 to 4 m.

Experienced fishers typically harvest fist-sized clumps of goose barnacles from a sea mussel or acorn barnacle matrix, prying each clump off with a long flat steel bar. This harvest method produces holes or divots in the mussel layer or patches of bare rock in acorn barnacle areas. Three months after harvesting, the holes created in sea mussel areas had largely filled in through realignment of contiguous sea mussels: Bare rock was still evident in the harvested acorn barnacle areas. Reduced community biomass was visible at most intensively harvested sites. It was reported by experienced harvesters that this was due to the area having been harvested by inexperienced harvesters.

Reviewers' Comments

Reviewer 1

This reviewer noted the working paper to be a good start at the challenging task of describing west coast of Vancouver Island goose barnacle/sea mussel ecosystems. The working paper met the objective of delivering initial results, however, study design and statistical procedures merit closer attention for any on-going assessment. For example, it was often not clear which hypotheses the authors were attempting to nullify at the various sites, though uncertainty in the analysis was provided. It was not clear if the authors were, or were not, conducting a 'broad brush"/preliminary analysis. The recommendations, however, were provided in a useful format for habitat managers. It was urged that the experimental plots be clearly marked and geo-referenced for the expected long term serial observations that will follow, and that time of impact be accurately recorded. It would be preferable that a quantitative pre-impact reference site and treatment site be defined, along with attendant hypotheses and an appropriate statistical model.

In addition, the reviewer requested that "community structure" be clearly defined, and that statistical indices for species diversity, and evenness and richness be presented, along with the rationale for choosing these indices. There are investigators critical of their use. The reviewer suggested that a protocol for habitat assessment should be provided.

Reviewer 2

This reviewer found the working paper to contain novel information on the interaction between goose neck barnacle diversity and characteristics of the substrate species. The information will be invaluable in measuring the impact of harvesting by goose barnacle harvesters. Numerous editorial comments were provided to the authors along with the following more specific concern:

- The authors should describe the relationships between average matrix thickness and goose barnacle peduncle length; and between displaced volume and rostral-carinal length to determine the sensitivity of these measures to the matrix substrate or tidal height.

Subcommittee Discussion

The Subcommittee agreed that there appeared to be a mismatch between the authors' presentation to the Subcommittee and the objectives of the working paper. In the presentation, there was frequent mention of harvesting impact and yet the paper included little data on impact. The authors noted that this preliminary work describes the pre-fishery situation and the species diversity and substrate matrix from windward and leeward sites. Post-harvest samples have not been collected, thus this work did not measure impact. It was agreed that when this is done, the number of "clumps" removed will need to be known, and thus the actual harvest area per-unit-area (i.e., hectare) of habitat. It was also unclear if the study will extend to other species in the food-web, and to the impact on the habitat overall. It was noted that much less than 1% of the matrix is removed in harvesting, and that species diversity was higher in mussel matrix than in the acorn barnacle matrix, likely because of deeper interstitial areas in the former than the latter.

It was learned that the fishery is site specific and time dependent during the harvesting operation. Rotation of 'crop' is practiced, and it is market driven; "top dollar" going to the harvester with the best product. There is a seasonal component that should be included in the experimental design. It is clear, the community sampled sets the stage for the habitat assessment, and so specifics on sampling must be provided. Recruitment needs resolution in the working paper, i.e., settlement on harvester-scraped bare rock as compared to juveniles and adult mussels "rearranging" to cover divots.

There was a paucity of Traditional Ecological Knowledge provided: the authors were requested to include this information, along with maps that provide bed scale, bed location in relation to wave exposure, and tidal elevation.

Subcommittee Recommendations

1. The Subcommittee recommended that the working paper be accepted subject to revisions

2. The Subcommittee recommended that the information from the PSARC Invertebrate Subcommittee gooseneck barnacle working paper ultimately be combined with the above working paper. Information is required on the size of the potential resource, the impact of the fishery in a given area, and how much of the area should be harvested.

3. The Subcommittee recommended that a study should be designed to assess the recovery of the goose barnacle sites harvested in the fall of 2000. The prime hypothesis to be nullified is, "that there are no changes in goose barnacle community structure following harvesting". The study should specifically assess the "pioneering species", those that establish first following

harvest, and their growth rates along with species succession. The following should also be included:

- A study design that has more controls and types of impact sites, to examine classes of impacts (e.g., divots versus clearing to bare rock). It will be important to track in a more rigorous way harvesting impacts from a known point in time and place;
- A more rigorous analysis of the relationships between goose barnacle physical measurements and matrix thickness according to mussel or acorn barnacle substrate;
- A quantitative assessment of goose barnacle habitat destruction from both natural and anthropogenic causes over time;
- Alternate methods of species diversity analysis needs to be employed and used to investigate barnacle community alteration; and
- The determination of acceptable perturbation by matrix characteristics is an important step in the development of a Harvesting Code of Practise for fishers, with subsequent monitoring to examine its implementation.

H2001-03: Marine and estuarine riparian habitats and their role in coastal ecosystems, Pacific Region.

C. Levings and G. Jamieson **Accepted subject to revisions**

Summary

This paper is an assessment of the fish habitat for a particular ecotone of the marine and estuarine shoreline in British Columbia; specifically that area where aquatic habitat at higher tides merge into the terrestrial habitat. Scientific data on these marine riparian habitats are scarce in Pacific Region, and habitat managers are thus dealing with uncertainty when assessing these areas in relation to forestry operations, urban development, and other developmental activities. There is substantial evidence showing that unvegetated beaches in the marine riparian are used as spawning and incubation habitat for sandlance and surf smelt. Marine riparian is also recognized as rearing and migratory habitat for juvenile salmonids. Preliminary studies conducted in Howe Sound and near Parksville in February and March 2001 showed that a variety of arthropods are potentially available as fish food from intact marine riparian habitats. The functional importance of marine riparian is likely to be related to food production, temperature regulation, wave energy absorption, and provision of structure as well as indirect ecological value. As an interim measure, based on the sparse available literature, the authors recommend that a site-specific approach be taken to buffer zone widths to manage the marine riparian. Gravel, sand, or cobble beaches may be most susceptible to erosion and sediment sloughing from land, depending on back-shore conditions. For these habitats the authors recommend a minimum 15 m setback. The authors also recommend a careful review of the rationale, efficacy, and performance of the wider setback distances

adopted in 1998 by the Scientific Panel for Sustainable Forest Practices in Clayoquot Sound. There may be a need to implement the latter distances elsewhere in the Region if the precautionary approach is being taken. Research papers and projects on the importance of marine riparian habitat in Pacific Region are absent, in sharp contrast to the numerous reports and ongoing projects dealing with freshwater riparian. Several focused research projects are recommended.

Reviewers' comments

Reviewer 1

Reviewer 1 predicted that this working paper will be an important contribution to habitat managers as there is a paucity of published information on the marine "riparian" zone. The review also suggested that riparian should not be used in the marine context (the word is derived from the latin "riparius", which means river) and that the appropriate term would be "supralittoral". Given that so little is known about this zone, the reviewer urged the authors' to extend their advice on future research in the marine "riparian".

The reviewer felt the authors should clarify the vertical height of the zone, and suggested that no matter how high a contiguous cliff might be, that the marine riparian extend to the top of the cliff. The rationale is that it is the presence of the cliff, not its height that is the important variable. In addition, it was argued that the authors direct the working paper to anthropogenic impacts such as shoreline stabilization procedures, because natural sedimentary processes play an important role in beach building, etc.

The reviewer added two items to future research:

- observation of changes in ecological function with the removal of shoreline armouring; and
- documenting the value of natural vs. unnatural marine "riparian" areas to detritus recycling.

Reviewer 2

This reviewer acknowledged that the authors are the local experts on this topic, and agreed with the authors, that little is known about the marine riparian zone and its contribution to fish and fish habitat. One problem noted with freshwater riparian guidelines is the lack of "modifiers" such as slope stability, that are based on local topography, local values and other ecological criteria. Given as an example is degree of wind fetch, which should, in part, dictate marine riparian width. In addition, estuaries will likely require different protection to an exposed rocky shoreline. However, the reviewer went on to argue that without considerable research it will be most difficult to set an appropriate set back distance. Much research is required in this area before something other than

"provisional guidelines" can be offered to the habitat manager, who might use them in the precautionary sense. This reviewer felt that if the research is not done, it will leave the Department open to criticism, and erode credibility. The list of research provided by the authors was supported, as was their argument that the list was not inclusive.

Subcommittee Discussion

The Subcommittee agreed with reviewer 1 that "marine" should not be used with riparian and that The Land Titles Act provides the term "natural boundary" for the area along a waterbody. However, it was agreed the authors continue use of "marine riparian" in the working paper, but with a textual explanation following first useage.

One Subcommittee member noted that it was critical that a mechanism for assigning relative values to the various habitats encompassed within the "marine riparian" zone be developed. The value, however, should be in terms of fish habitat (e.g., as food supply areas) and not as fisheries habitat as stated in the working paper, though it was agreed that, given the ubiquitous distribution of juvenile salmonids most fishery habitat was also fish habitat. Legal advice argues that legislation is to protect fish, not fisheries.

Some Subcommittee members felt that habitat sensitivities were needed, but all agreed, the marine riparian zone met the definition of fish habitat.

It was questioned as to why the working paper moved to a proposed 15 m buffer from 30 m. The distance to be designated as a buffer zone should be determined by that needed to protect fish and habitat under site-specific circumstances, and not on land usage. The authors agreed. One of the authors pointed out during discussion that their provisional seaward boundary for the marine riparian zone will not be the high tide line as proposed elsewhere, but some distant landward of this line. A suggestion was made that management guidelines would vary considerably because of the wide range of ecological and physical processes encompassed within the marine riparian zone. If the intent of guidelines is to preserve natural functioning, then different sets of guidelines should be considered for the range of habitat types such as forested rocky shorelines, tidal freshwaters areas, beach dunes, etc. The authors noted that the Clayoquot Sound scientific panel had used shoreline classification, and as well, had applied different guidelines or criteria per habitat type, but unfortunately published technical material could not be located. Thus, how successful the system has been cannot be reported.

It was noted that boundary location of the proposed buffers was not clear, which will hence impede application. It was thus recommended that all reference to a 15m buffer be deleted before it would become a *de facto* standard wanting scientific support. Lessons may be learned from freshwater setback width, which

is often negotiated on a site-specific basis, depending on perceived value of the habitat. A large challenge will be to address the issue of relative value and/or sensitivity of habitats within the marine riparian zone.

The authors suggested the working paper be used as the basis for a workshop to set provisional management guidelines for marine riparian habitat and the Subcommittee agreed. If provisional guidelines could be agreed upon, based on ecological and/or physical processes, then habitat managers, using the working paper for support, could apply them using the precautionary principle.

Subcommittee Recommendations

1. The Subcommittee recommended that the paper be accepted, subject to revision.

2. The Subcommittee recommended that a workshop be organized to develop provisional marine riparian management guidelines, and that the workshop organizers use this working paper as the basis for discussions.

H2001-04: Phase 0 review of environmental impacts of shellfish aquaculture in Baynes Sound

G.S. Jamieson, L. Chew, G. Gillespie, L. Bendell-Young, A. Robinson, B. Bravender, A. Tompkins, B. Carswell, B. Heath, D. Nishimura, and P. Doucette **Accepted subject to revisions**

Summary

Shellfish aquaculture has taken place in coastal British Columbia (B.C.) since the early 1900s, and Baynes Sound has developed into one of the major production areas of cultured shellfish in the province. There have been very few scientific studies of the environmental impact of shellfish aquaculture to date, and the most notable management issues have centered around land use conflicts with adjacent upland owners, recreational harvesters, wild harvesters, other recreational activities, and navigation. Recently, ecosystem concerns have been published regarding intertidal bivalve bottom culture practices (e.g., Simenstad and Fresh 1995), and the existing and planned expanded scale of this aquaculture in B.C. has raised concerns among DFO and B.C. Ministry of Water, Land and Air Protection resource managers, particularly in Baynes Sound.

In the working paper, the authors present a Phase 0 habitat review of Baynes Sound intertidal shellfish aquaculture to provide a baseline with which to advise on alternative management options and to identify where information is lacking. The authors: 1) review the existing scientific literature on the potential environmental impacts of intertidal bottom culture aquaculture on coastal ecosystem processes, specifically relating to fish and fish habitat in the Pacific

north-east; 2) describe the current practices of intertidal bottom culture operations and their potential impacts in Baynes Sound; 3) assess the need for monitoring and/or a cumulative effects study related to planned increases in total amount of leased area in the intertidal zone of Baynes Sound; 4) identify gaps in the understanding of ecosystem impacts of extensive, intensive intertidal bottom bivalve aquaculture; and 5) make recommendations for future research support of ecosystem-based intertidal bivalve aquaculture management.

The authors have made every possible effort to bring together available information for this study, but have found that relevant existing studies are relatively few and were limited in scope and rigour. The literature is fragmented, and much available information has not been formally reviewed and published. When available, the views expressed are thus more hypothesis-generating than definitive, which warrants a need for their rigorous testing and evaluation.

Reviewers' Comments

Reviewer 1

The reviewer commended the authors for their having collected so much information from such diverse sources over a relatively short time frame (four weeks). The reviewer indicated that the purpose of the paper was clearly stated and the data more than adequate to support the recommendations of the working paper. The reviewer outlined how the recommendations were useful to habitat managers. The reviewer also stated that the knowledge gaps were well identified and that a useful list of scientific issues needing resolution were provided. The reviewer suggested that an overall editing of the paper be undertaken to enhance readability. This reviewer was particularly concerned about the difficulties in applying DFO's Habitat Policy and the *Fisheries Act* to the development of intertidal shellfish aquaculture operations in Baynes Sound.

Reviewer 2

The reviewer offered that while the working paper provides a good physical and biological overview of the Sound, additional physical oceanographic information would be useful. The long list of research problems should be shortened, as many are likely intractable, and they should be prioritized against needs for mitigation and management. The reviewer agreed with the authors that little is known in this area, hence care should be taken when warning about the extent of environmental impacts; the extensive list of potential impacts, some with perhaps little significant risk, only detract from the paper. The reviewer argued for a more balanced approach, and urged that benefits of shellfish aquaculture be included, e.g., high densities of filter feeders can improve water quality, and the presence of the industry could bring to the fore, the matter of declining water quality. Generally the reviewer reports that insufficient information is presented to support the recommendations, and suggested that productive capacity in certain shellfish

farms may actually increase over that of the more natural state, and that this enhanced productive capacity could be viewed by habitat managers as compensation for productivity lost.

Subcommittee Discussion

The Subcommittee accepted the manuscript with revision. Some of reviewer 2's suggestions should be incorporated into the revised manuscript. However, the Subcommittee did not support several comments from this reviewer including the statement "... there is insufficient justification in the paper to support the recommendations". The primary issue arising from this paper is the scale of impact on both ecosystem and habitat, and the cumulative impact of further insults. The Subcommittee also noted that a GIS data-base defining the cultured areas for the different farmed species is unavailable.

Subcommittee Recommendations

1. The Subcommittee recommended that the working paper be accepted subject to revisions.

2. That Baynes Sound is an important system within Georgia Basin and therefore should be better understood before irreversible change takes place. Consequently, implementation of a Phase 1 study for Baynes Sound is recommended.

3. That an effective network of protected areas be established in Baynes Sound that would include sensitive habitats.

4. That Baynes Sound ecosystem be considered as a potential site to undertake a cumulative effects study on the impact of shellfish culture.

H2001-05: A proposed MPA boundary identification process for reproductive refugium establishment, using lingcod *(Ophiodon elongatus)* as an example focal species

G.S. Jamieson and S. Dixon **Accepted subject to revisions**

Summary

The boundary of a finfish stock-rebuilding marine protected area (MPA) is likely to be a function of local bathymetry, management objectives for the Area, and the biological characteristics of particular focal species, if identified. For many MPAs, there may be an obvious bathymetric outer boundary (e.g., a bay, reefs around an isolated island, etc.), but for those where this is absent, the outer boundary may be delineated by management objectives along with the biological characteristics of the focal species. In this working paper the authors consider

boundary delineation of an Area of Interest (potential MPA) designed to serve as a reproductive refugium for lingcod (*Ophiodon elongatus*), from a science perspective, and consider the nature of the biological data that would be required to set the MPA boundary.

Based on a literature review for lingcod, a number of important information gaps for this species were identified. First, there is no estimate of the minimum numerical abundance required to meet a desired reproductive potential. Secondly, to estimate the size of a "no-harvest" Area required to sustain a specified lingcod population size, information is needed on the densities of both males and females at size, that can be supported in a range of habitats, and the dispersal characteristics of individuals by size, neither of which are well described for lingcod. The authors thus estimated MPA boundaries for a hypothetical lingcod refugium based on the assumptions that: 1) an appropriate "protected" population size would be present along an arbitrary six km of longshore rocky shoreline, 2) that this population would be centred within the MPA, and 3) that the average annual home range for lingcod is a meaningful criterion to determine the distance the MPA boundary should be from the edge of the target lingcod population.

With these assumptions, a refugium MPA for lingcod would extend 34 km in any direction from the identified core lingcod habitat. Also, given that there is no Canadian history on the use of MPAs to rebuild finfish populations, appropriate follow-up monitoring will be required so that adaptive management can be implemented. The authors main recommendation is that since establishing an MPA for the purpose of rebuilding depleted fish stocks requires considerable species-specific biophysical data, managers are urged to identify candidate species at the earliest possible time so that available data can be assessed and, if deemed deficient, additional data can be obtained.

Reviewers' Comments

Reviewer 1

The reviewer compliments the authors for their efforts, and suggested the prime contribution of the working paper is to point out the deficiencies in data that likely exist for most "focal" species that the Region is likely to target for the development of conservation-MPAs. The reviewer suggested that the methodology chosen to enhance information on lingcod ecology should be expanded beyond dive surveys to at least include tagging studies. The reviewer recommended the working paper be accepted with the *provisio* that any mention of Gabriola Pass be removed, since an MPA supporting lingcod conservation has never been proposed. The reviewer urged the working paper, in rewrite, to center on the inadequacies of biological data available to define MPA boundaries. The reviewer also warned that an MPA boundary, constructed with inadequate data, is not defensible.

Reviewer 2

This reviewer noted that the objectives of the working paper are clearly stated, but felt the authors should have given a range of boundary distances rather than a single distance of 27km, and that risks be provided for use by managers when choosing a boundary. The reviewer debated the authors' conclusion that fecundity levels in lingcod are depressed, and stated "...lingcod are a highly fecund species with an opportunistic life history strategy....recruitment is dependent not on the number of spawners nor the size of spawners, but ... on suitable environmental conditions...". The diving methodology discussed in the working paper was deemed irrelevant to the objectives of the working paper and should be deleted. Furthermore, if the objective of the MPA is to serve recruitment beyond the MPA boundaries, then consideration should be given to larval and juvenile dispersions, a component not discussed in the working paper.

Subcommittee Discussion

The senior author rebutted Reviewer 2's comments on the importance of environmental conditions as opposed to fecundity, using the examples given by Hutching's at a recent conference. Hutching's studies are now showing that population size is of particular importance. Regardless of whether a population is depleted or not, individuals seem to produce <20 adult progeny over their lifetime. This may, in part, explain why certain severely depleted, high fecund species take a longer time than predicted to recover from recruitment over-fishing. The senior author stated that on-going successful recruitment of highly exploited, fecund animals are usually due to the existence of some sort of refugia. It was surprising to learn that despite the long period of lingcod exploitation, and the number of biological and fisheries studies undertaken over this period, that there is still insufficient information on which to make basic assumptions regarding optimum size and location of a MPA for this species.

There was considerable discussion as to why habitat managers or ocean managers would recommend target species and abundance levels, this being the purview of fisheries managers. It was concluded that habitat parameters should be able to describe nest sites. However, if habitat is not impacted, and fish abundance is a problem, then it should be a fisheries management issue. There was also a question as to whether MPAs should, or indeed would be handed over to habitat managers once established. There was considerable discussion on the purpose of the Gabriola Pass area of interest. It was suggested the original proposal came from the dive community seeking a reserve for charismatic mega-fauna.

It was concluded that there are additional needs for meta-population analysis and dispersal characteristics for *O. elongatus* prior to defining site-specific boundaries for a MPA.

The working paper demonstrates the extensive information requirements for the creation of a fishery-based MPA. It was suggested that the exercise could have been carried out without using Gabriola Pass as the hypothetical MPA.

There was considerable Subcommittee discussion as to whether the outlined process was appropriate; the Subcommittee could not resolve the issue based on the available information. The senior author argued for home range, fidelity, and fecundity data. Other requirements are larval distribution and drift parameters, habitat delineation, and the need for meta-population analysis.

Subcommittee Recommendations

1. The Subcommittee recommended that the working paper be accepted subject to revision.

2. That the establishment of an MPA for the purpose of rebuilding depleted fish stocks requires considerable biological, and bio-physical data. Managers are therefore urged to identify candidate species early in the conservation process.

APPENDIX 1: PSARC HABITAT WORKING PAPERS AND REVIEWERS FOR JUNE 2001

No.	Title	Author
H2001-01	Factors limiting sockeye production on selected B.C. nursery lakes	K.S. Shortreed K.F. Morton K. Malange J.M.B. Hume
H2001-02	Community structure in goose *barnacle (Pollicipes polymerus)* and sea mussel (*Mytilus californianus*) beds off the west coast of Vancouver Island, British Columbia	G.S. Jamieson S. Dixon R. Lauzier
H2001-03	Marine and estuarine riparian habitats and their role in coastal ecosystems, Pacific Region	C. Levings G. Jamieson
H2001-04	Phase 0 Review of the Environmental impacts of Shellfish Aquaculture in Baynes Sound	G.S. Jamieson L. Chew G. Gillespie L. Bendell-Young A. Robinson B. Bravender A. Tompkins B. Carswell B. Heath D. Nishimura P. Doucette
H2001-05	A proposed MPA boundary identification process for reproductive refugium establishment, using Lingcod (*Ophiodon elongatus*) as an example focal species	G.S. Jamieson S. DIxon

Reviewers for the PSARC papers presented at this meeting are listed below, in alphabetical order. Their assistance is invaluable in making the PSARC process work.

J. Cordell	University of Washington
B. Heath	B.C. Ministry of Agriculture, Food and Fisheries
J. King	DFO, Pacific Region
R. Lauzier	DFO, Pacific Region

E. MacIsaac	DFO, Pacific Region
D. Noakes	DFO, Pacific Region
P. Rankin	DFO, Pacific Region
J. Richardson	University of British Columbia
T. Sutherland	DFO, Pacific Region
R. Tanasichuk	DFO, Pacific Region

APPENDIX 2: PSARC HABITAT SUBCOMMITTEE MEETING AGENDA, JUNE 2001

PSARC HABITAT SUBCOMMITTEE
June 26-27, 2001

MILNE ROOM, IOS
Starting Time, 0900 h

Tuesday, June 26, 2001

1. Introductions and Procedures
2. Review Agenda
3. Review of WP H2001-01 – "Factors limiting sockeye production on selected B.C. nursery lakes" by K.S. Shortreed et al.
4. Review of WP H2001-02 - "Community structure in goose barnacle *(Pollicipes polymerus)* and sea mussel (*Mytilus californianus*) beds off the west coast of Vancouver Island, British Columbia" by G.S. Jamieson et al.

Wednesday, June 27, 2001

5. Review of WP H2001-03 – "Marine and estuarine riparian habitats and their role in coastal ecosystems" by C. Levings and G.S. Jamieson
6. Review of WP H2001-04 –"Phase 0 Review of the Environmental Impacts of Shellfish Aquaculture in Baynes Sound", by G.S. Jamieson et al.
7. Review of WP H2001-05 – Marine Protected Area Species Assessment, by G.S. Jamieson
8. Review of agenda for December 2001 meeting

APPENDIX 3: PARTICIPANTS AT HABITAT SUBCOMMITTEE MEETING, JUNE 2001

Subcommittee Chair: John Pringle
PSARC Chair: Max Stocker

Name	Affiliation
Andrie, D.	DFO, Oceans
Barry, K.	DFO, HEB
Birtwell, I.*	DFO, MEHSD
Cherniawsky, J	DFO, OSAP
Chew, L.	DFO, MEHSD
Clark, D.	DFO, Fisheries Management
Dixon, S.	DFO, MEHSD
Foreman, M. *	DFO, OSAP
Gillespie, G.	DFO, StAD
Hietkamp, F.	DFO, Oceans
Jamieson, G.*	DFO, MEHSD
Kotyk, M.	DFO, HEB
Lauzier, R.*	DFO, StAD
Levings, C.*	DFO, MEHSD
MacDonald, B.*	DFO, HEB
MacKinley, D.	DFO, HEB
Morgan, A.	DFO, HEB
Nishimura, D.	DFO, HEB
Northrup, S.	DFO, HEB
Reid, B.*	DFO, HEB
Samis, S.*	DFO, HEB
Shortreed, K.	DFO, MEHSD
Spigelman, A.	DFO, MEHSD
Yeon, I.	Visiting Scientist (MEHSD), Korea

External Participants

Name	Affiliation
Barrie, V. *	Natural Resources Canada
Heath, B.	BC Fisheries
Marliave, J.	Vancouver Aquarium/PFRCC
Robinson, C.*	Parks Canada

* Denotes Habitat Subcommittee member.